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Apple Scab and Its Control

SCABBY BALDWINS — THE PENALTY FOR POOR SPRAYING

By

A. L. Pierstorff

Extension Specialist in Plant Pathology
The Ohio State University

OHIO STATE UNIVERSITY AND THE UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING
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Fig. 4.—Section through a scab fruiting body as seen through a high powered microscope.

Latin name, *inaequalis*. On the average there are at least 50 of these spore sacs, or asci, in each fruiting body, and with 8 spores in each ascus, there would be more than 400 spores per fruiting body. As shown in Fig. 3, one-fortieth part of a leaf may have over 100 of these perithecia, so one leaf could contain more than 4,000 fruiting bodies or 1,600,000 scab spores.

Why should you as a fruit grower be interested in these figures? Just follow along for a minute and you will understand the necessity of thorough spraying.

You will probably admit that there are at least 10 scabby leaves per tree in your orchard, which is not very many when you consider that an average apple tree has at least 30,000 leaves. On this basis there would be produced *100 or more spores per square inch* during a normal spring.

How thick would the spores be if there were 100 per square inch? Place 100 pencil dots in the 1-inch square and you will be surprised to see how close they are to each other. This demonstrates how thoroughly a spray must be applied to kill all scab spores. It is easy to see that any portion of the foliage which is missed by the spray will surely get scab, because there is plenty of opportunity for scab spores to be present and cause infection.

Also, looking at it in this way, it becomes quite evident that raking up and burning, or plowing down the scabby leaves, is of little value when one or two leaves produce so many spores. Growers sometimes wonder why they have so much scabby fruit. To me, the wonder is "Why do they have any clean fruit?"

Scab in Spring

Naturally you ask, when are all these spores produced and what type of weather conditions promote spore production? As a rule some scab spores are mature by the time apple buds reach the delayed dormant stage, as illustrated in Fig. 5. Sometimes they mature earlier and we have frequently found them ripe in some sections of Ohio as early as February. Most of the scab spores mature after green foliage is present on the tree, and are discharged *only during rainy periods*.

Three things are necessary before scab infection can take place: First, there must be green leaves on the trees; second, moisture (rain) must be present; third, the spores must be mature and ready to shoot.

Spores Shoot from Sacs.—The method by which these spores are shot into the air is very interesting. Before maturity glycogen, a carbohydrate material something like sugar, is formed in the base of the spore sac. However, this material does not absorb water readily. After maturity the glycogen changes to sugar, which takes up water rapidly, and as more and more water is absorbed into the spore bearing sac, the pressure becomes greater and greater until finally the sac breaks and the spores are forcibly shot into the air. Sometimes the top one-third or one-half of the fruiting body is blown off by this explosion.

How high do these spores shoot? I have had many fruit growers guess on this point, and some have reasoned that since scab is abundant in the tops of some of their apple trees, the scab spores must shoot that high. This would be a long shot for such a little spore, and the best measurements indicate that ½ inch is about the maximum height.

Fig. 5.—Delayed dormant stage.

Spores Float in Air.—However, these seeds are so light that they are readily carried by air currents. They float about in the air until they settle on some object just as dust settles on a table top. If this landing place is a limb or trunk of an apple tree, or any place other than a green apple leaf, or fruit, the spore dies and cannot reproduce itself. If it settles on a green apple leaf and moisture is present, it germinates just as any other seed and starts growing into the leaf. It grows right through the cuticle of the leaf and in four to five hours is inside, if the temperature is around 68° Fahrenheit.

Spore Germination Depends on Temperature and Moisture.—Scientists have determined that the rate of germination and penetration into the leaf depends upon the temperature. For example, at 43° Fahrenheit it takes 15 hours; at 48°, 11 hours; at 59°, 7 hours; at 68°, 4 to 5 hours; 75°, 6 hours; and 79°, 10 hours. It is evident, therefore, that the leaves must remain wet three times as long as 43° F. as at 68° F. in order to permit scab infection.

Not all the perithecia mature at the same time. You will notice by referring again to Fig. 4 that the perithecia are of different sizes; the larger ones are more nearly mature and consequently will discharge their spores first. Spore discharge from the old leaves may begin before the delayed dormant stage is reached. It usually reaches its maximum somewhere near the pink period, and continues until after petal fall (Fig. 6). If we have several long rains before bloom most of the spores are discharged during that period. However, with continuous rains, such as occurred during 1933, spore discharge and development continued until the end of the rains on May 26. As a rule, if the petal fall spray is thoroughly applied and the pre-blossom sprays preceding

it have been well timed and thorough, our fight against apple scab for that season is won.

Scab in Summer

If some parts of the orchard have been unprotected, as they usually are, or rains have been too frequent during the spring, some scab spores may have penetrated into the green leaves. Then about one week after petal fall olive-green spots, as mentioned on page 2, begin to show on the foliage. On these spots a second type of spore is produced which may be termed a "summer spore," or "secondary spore." These summer spores are produced in countless millions, and are not carried by the wind, but are *washed* and *splashed* over the leaves and fruit below, during each rain throughout the summer and fall. The spread of scab from secondary spores is extremely difficult to check, and for this reason our control measures are directed most intensively at the primary spores.

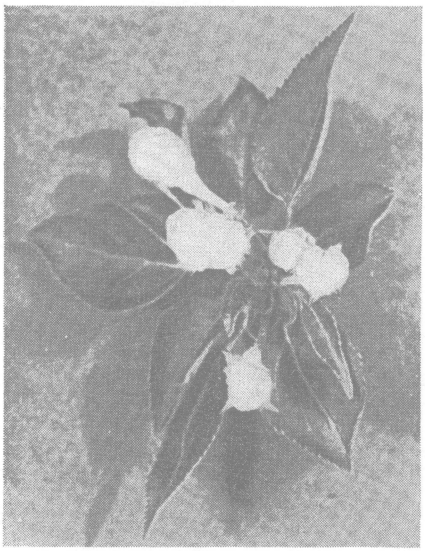


Fig. 6.—Pink stage.

The scab fungus is a cool weather organism, and is spread most readily during the spring and early fall. If there is considerable scab on the foliage, frequently the fruit is severely specked by harvest time. Sometimes infection is so late that it is scarcely visible at harvest time, and when such fruit is stored the scab continues to grow in storage, and apples which appeared to be clean at harvest time are scabby when brought from the storage. Therefore the late summer sprays should carry a sufficient amount of fungicide to insure against late infection.

It has been definitely determined that scab spores spread during harvesting operations do not cause infection, and that no further infection takes place during storage.

How to Prevent Scab Losses

Calculations on page 4 show that ten scabby leaves per tree may produce 100 spores per square inch during the spring of the year. This emphasizes the necessity of very *thorough* and *timely* spraying every spring, especially in locations where scab is a problem. Regardless of previous control, scab may be so serious during any one season as to ruin an entire crop, if proper control measures are not applied. The abundance or scarcity of scab one season has very little influence on its prevalence the following year. *Spring rains* are the deciding factor in respect to spore production and infection.

The most efficient control measures so far developed require the thorough application of sprays (from delayed dormant to calyx), just preceding rainy

periods which are of sufficient duration to permit infection. A spray applied within 24 hours after the beginning of a rain will kill out some recent infections, but cannot be relied upon to give control. Some years one pre-blossom spray is sufficient, but generally in central and northern Ohio two pre-blossom sprays are necessary in addition to the delayed dormant spray. During the 1933 season some growers applied as many as five pre-blossom sprays, and as later events proved were highly repaid. If the pink spray has been applied too far ahead of bloom or the season is exceptionally rainy, a spray in bloom is advised. This will not injure the set nor the bees if arsenate of lead is omitted.

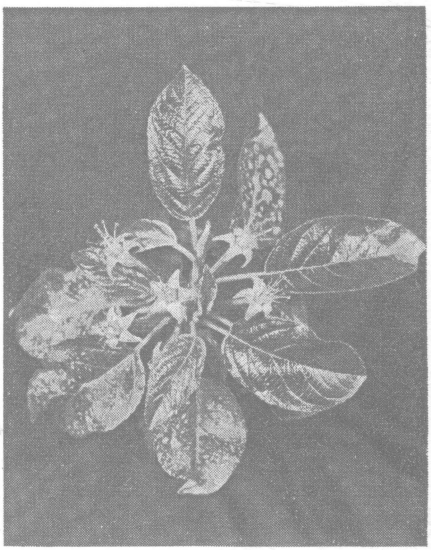


Fig. 7.—Calyx cup stage.

Spraying Suggestions.—General procedure would be about as follows:

A delayed dormant and one or more pre-blossom sprays, using either 6 pounds of dry or 2 gallons of liquid lime-sulfur to 100 gallons of spray.

A calyx spray of either 5 pounds of dry or 1½ gallons of liquid lime-sulfur. Another application 10 to 14 days after petal fall if one-fifth or more of the leaves show scab spots. Use dry lime-sulfur 4 pounds, or 1½ gallons of liquid for this and the two subsequent sprays, which should be timed 3 to 4 weeks and 9 to 10 weeks after petal fall. Eight pounds of lime should be added to each 100 gallons of spray if burning of foliage occurred in previous years.

Insects and other diseases may also be controlled while spraying for scab if other materials are added. For the complete spray schedule get a copy of Extension Bulletin 128 from your county agricultural agent.

Each fruit grower should study his location in respect to general conditions, and careful observation over a number of years will reveal whether or not he needs to apply more or fewer sprays than those recommended.

Control Secured of Apple Scab in Ohio Orchards, 1928-1933

Year	Number of Orchards	No. of Sprays Applied	Percentage of Scabby Fruit
1928	22	5.7	5.9
1929	23	7.3	10.04
1930	98	6.0	2.37
1931	94	5.5	2.0
1932	80	5.2	7.54
1933	45	6.0	5.3

That scab can be controlled in Ohio in all locations is evident when the preceding table is studied. The growers' orchards used in these tests were not selected from the standpoint of scab freedom, but scattered throughout the state. Many of them are located in areas where scab is an annual problem.

Every detail of the spray equipment should be in the best working order to wage a successful fight against scab. Providing an adequate water supply in the orchard at one or more locations, or hauling water to the sprayer in a supplementary tank, will frequently double the number of gallons applied in one day.

Our records show, that where poor control has been secured, the one general shortcoming, present in more orchards than any other, is the *failure to spray thoroughly*. It would help many growers if they would study the spray methods of a neighbor who is successful in scab control. *Thoroughness, timeliness*, and *proper materials* are the big three in spraying. If they are practiced, clean fruit instead of alibis will be the result. Remember that "nature waits for no man."

Summary for Control of Scab.—In brief, if poor control of scab has been obtained, permit me to suggest the following procedure:

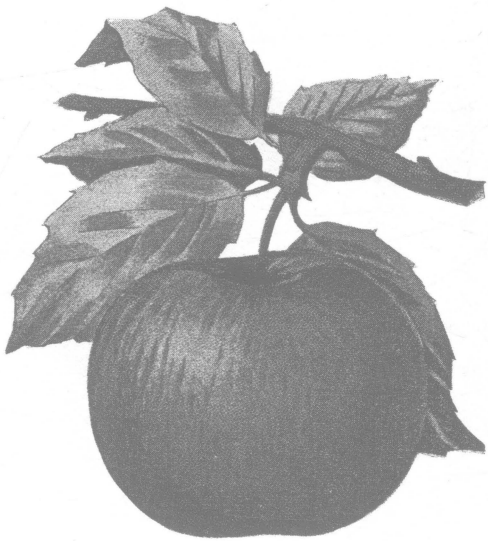
Make sure that your spray equipment is in excellent condition and of sufficient capacity to cover your orchard in not longer than two days.

See your county agricultural agent and ask that your name be placed on his spray service mailing list.

Tune in on the radio broadcasts, which are usually given about noon over WLW, Cincinnati, and WTAM, Cleveland, and an hour earlier over WOSU, the Ohio State University Station, from the last of March, until the middle of May.

Spray *thoroughly* and *on time.*

Use standard materials in correct dilutions.



THE REWARD OF THOROUGH SPRAYING